
Transmission performance

Voice quality performance

The quality of voice connections made over tandem trunks is a function of the composite characteristics of the trunks. Each trunk added to the connection degrades the overall transmission performance. Thus, some limits must be placed on the number of trunks permitted in tandem, as well as on which trunks may be connected.

To maintain adequate voice quality while keeping the routing restrictions from becoming unduly complex, ESN is partitioned into two basic connection categories, each with its own set of requirements. The connection categories are as follows:

- node-to-node
- node-to-main, satellite, or tributary

Node-to-node connections

The restrictions on node-to-node connections are the following:

- No trunk has a loss exceeding 3.5 dB.
- No combination of trunks used for a valid connection have a loss exceeding 4.1 dB.
- Split echo suppressors are provided at each end of each trunk equipped with echo suppressors. Each echo suppressor is enabled or disabled by the switch at its end.
- Tandem connections of echo suppressor-controlled trunks are permitted, provided the intermediate echo suppressors are disabled. The switch disables the echo suppressors it controls when a direct connection is made between two echo suppressor-controlled trunks, thus meeting this requirement. Routes with one (or more) intermediate non-echo-suppressor-controlled trunks between echo suppressor-controlled trunks are not allowed because the intermediate echo suppressor is not disabled.
- Generally, no more than three tie trunks should be connected in tandem. A limit of four is imposed between echo suppressor-controlled trunks. Software is arranged to disable echo suppressors when it tandems a call from an echo suppressor-controlled trunk to another such trunk. It does not disable echo suppressors on other connections.

Node-to-main, satellite, or tributary connections

Restrictions on these tie trunks follow.

- The node-to-main trunk is normally a land circuit not exceeding 250 miles (400 km). If this is not the case, the main PBX is treated as a node for transmission planning. The transmission planning of the node-to-main tie trunk is considered part of node-to-mode transmission planning.
- The node-to-main tie trunk, if less than 250 miles, must have a loss not exceeding 2.5 dB.
- Main-to-satellite and main-to-tributary trunks must have a loss not exceeding 2 dB.

Note: In some cases, the telco may be able to provide only non-VNL trunks, which have a loss exceeding these objectives. If the loss is significantly higher than VNL, the switchable pad must be in the “pad-out” mode for connection to these trunks.

To minimize toll charges, ESN can route calls over private network facilities to public network trunks. The public network has a designed loss that does not take into account the added loss of extending the call over private network facilities.

ESN, like any other private network, provides lower quality connections than a call routed directly to the public network. The amount of degradation must be kept small enough that the connection is acceptable to most users. This loss is restricted as follows:

- Off-network long-distance connections are to be established only from trunks terminating on nodes. The private network loss added to the public network loss is limited to the following:
 - 4.1 dB for calls originating at node stations
 - 6.6 dB for calls originating at main stations
- Off-network local connections can terminate at nodes and main PBXs. For nodes, the loss is the same as above. For mains, the loss is limited to the following:
 - 6.6 dB for calls originating at node stations
 - 9.1 dB for calls originating at main stations

Voiceband data performance

Voiceband data modems are used to transmit data between private network switches. General guidelines on the expected performance of various modem types for different ESN connections are provided in [Table 9](#) and [Table 10](#).

These guidelines are based on documented transmission performance of Bell System private lines and actual measurement of the Meridian 1 and several metropolitan area private lines. The expected performance is stated in statistical terms only to reflect the wide performance range of actual circuits.

The probability of success in completing a data call is based on an overall average of all Bell System private lines. A particular line or group of lines may be better or worse than the average. The expected performance stated here should be used only as a general indication.

[Tables 9](#) and [10](#) specify the expected performance for ESN connections with one, two, and three trunks in tandem. The percentage of successful calls is given for a given modem bit-rate. [Table 9](#) applies to modems with automatic adaptive equalizers; no significant improvement is expected with C2 or C1 conditioned lines compared with basic-quality private lines. Using D1 conditioned lines (guaranteed lower noise) can improve performance as shown in [Table 9](#). For modems without automatic (fixed) equalizers, significant improvement over basic line performance can result from using C1 or C2 conditioning, as shown in [Table 10](#).

Table 9
Performance of modems with automatic adaptive equalizers

Modem bit rate (probability of success)		
Number of trunks connected in tandem	Basic C1, C2 conditioning	D1 conditioning (4-wire facility)
1	2400 b/s (80%)	4800 b/s (<80%)
2	2400 b/s (50%)	4800 b/s (50%)
3	Not recommended	2400 b/s (50%)

Table 10
Performance of modems with fixed equalizers

Number of trunks connected in tandem	Modem bit rate (probability of success)		
	Basic conditioning	C2 conditioning	C3 conditioning
1	2400 b/s (75%)	2400 b/s (80%)	2400 b/s (90%)
2	2400 b/s (50%)	2400 b/s (60%)	2400 b/s (75%)
3	Not recommended	2400 b/s (50%)	2400 b/s (50%)